Centre of Excellence Telč

for interdisciplinary research on cultural heritage

A David among the Goliaths – the smallest European Centre of Excellence supported under the Operational Programme Science and Research for Innovations

MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

EVROPSKÁ UNIE
EVROPSKÝ FOND PRO REGIONÁLNÍ ROZVOJ
INVESTICE DO VAŠÍ BUDOUCNOSTI

2007–13
OP Výzkum a vývoj pro inovace

About CET (What is CET?)

CET – Centre of Excellence Telč is a project of the Institute of Theoretical and Applied Mechanics of the Academy of Sciences of the Czech Republic, which is being implemented with financial support from the European Union and the Czech Republic through structural funds and the state budget allocated to the Research and Development Operational Programme for the years 2007–2013.

The CET project was primarily intended to contribute to **the development of Czech and European science** by setting up a European Centre of Excellence as a leading research centre with a unique research programme and with international reach, especially in the broad field **research on cultural heritage**. The Centre is helping to present basic and applied research on a very high level in the Vysočina region and in Telč. The Centre aims not only to undertake activities in the Vysočina region in the European Research Area, but to open the region up to the world and to create favourable conditions for cooperation with other research and higher education institutions in the Czech Republic and elsewhere in the world. CET brings together joint teams or recruits external collaborators for its own projects and also for cooperation with the private sector.

CET is continuing with its research supported by the European Commission within the framework of the ARCCHIP Centre of Excellence, which was awarded a grant in the EC INCO Programme in 2000 as one of the only three Centres of Excellence in the Czech Republic. Since that time, the research has been supported by numerous national grants, by sixteen EC projects within the framework programmes for research and development, two grants from the US National Science Foundation as a part of US-Czech research cooperation, and several international bilateral projects. ITAM CET was a partner in the Noah's Ark consortium, which was awarded the Grand Prix of the EC and the Europa Nostra Award for the best cultural heritage research in 2009.

The Centre of Excellence has been established for research on historic and other materials and structures. In particular, it is equipped with unique equipment specially designed and manufactured with a view to obtaining fundamental knowledge and verifying the application and innovation potential of newly-developed technologies in the domain of diagnostics, life cycle extension, preventive protection and conservation, including long-term sustainable use of the existing building stock and technical materials. The major equipment of the Centre consists of the Climatic and Boundary Layer Wind Tunnel "Vincenc Strouhal", which is environmentally and economically ideal for the research on structural materials and technologies. It is equipped with locally developed measuring and simulation tools, a unique high-resolution X-ray large-surface micro- and nano-tomography worksite, and with other specific database modules and tools used for monitoring climatic effects and their impact on the behaviour and life cycles of materials and structures, including architectural heritage. There is a unique mobile system for specific assignments related to conservation of cultural heritage under emergency situations.

Research Programme

The Materials, Technologies and Methods for Long-term Preservation of Material Cultural Heritage research programme is divided into three work packages, which take into account the specific features of the unique equipment of the Centre and its mutual cooperation programmes:

- Modelling the behaviour of historic and modern materials and structures, with the synergetic effects of climatic factors.
- A study of the lifetime and degradation processes in construction materials and surface treatment of construction materials by means of advanced experimental methods.
- Materials, technologies and methods for achieving long-term preservation of monuments.

Research programme outputs

The main outputs will include the development and verification of methods for characterizing technical, mainly historic materials, studies of ways to influence and control the deformation and degradation processes in these materials, estimation methods and ways to extend the lifetime of cultural heritage structures, ways of preserving and protecting structures by means of suitable conservation materials, procedures and technologies for restoration interventions that are compatible with the values of the monument and take into account newly-acquired knowledge about the degradation mechanisms of historic materials due to the influence of external stresses and the external environment. Special attention will be paid to analyses of historic materials and technologies, and to identifying ways to reintroduce them to the monument or into wider construction practice.

The built infrastructure of the Centre will serve as a workplace where the scientific and research team can work on three long-term research activities and work packages which are mutually complementary, though activity can also fulfil specific tasks on its own.

Research programme supervisor:
Professor Ing. Miloš Drdácký, DrSc., dr. h. c.

Modelling the behaviour of historic and modern materials and structures under the synergetic effect of climatic factors

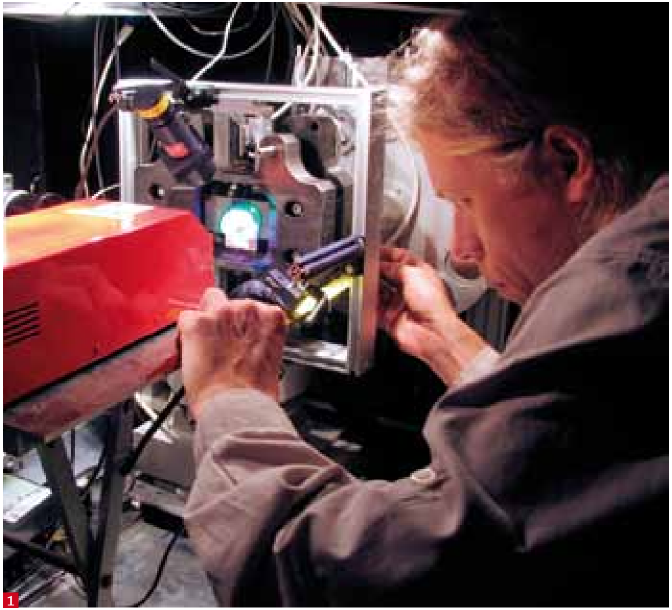
The scientific objective of WP1 is to create models of the interactions between solid bodies and the surrounding environment, utilizing the findings obtained by numerical and experimental modelling of the influence of wind on buildings, including monuments, and taking into account the influence of other weather factors: sudden or cyclic changes in temperature and rain effects. Another objective is to obtain new findings and knowledge through long-term sustainable monitoring and modelling of the behaviour of real structures that have been exposed to long-term weather effects and are susceptible to vibration and damage due to high-cycle fatigue. The outputs of the scientific projects are proposals for solutions to questions concerning the aeroelastic and aerodynamic behaviour of structures, as well as models and proposals for measures to provide a more comfortable environment for people living in housing estates and in the neighbourhood of transport structures. This is done on the basis of knowledge and simulations of the most important climatic parameters: wind, thermal radiation, rain and humidity.

The research supervisor for Work Package 1 is **Associate Professor Ing. Stanislav Pospíšil, Ph.D.**
The head of the Wind Tunnel Laboratory “Vincenc Strouhal” is **Professor Ing. Sergej Kuzněcov, DrSc.**

A study of the lifetime of construction materials and degradation processes in them, and of surface treatment of materials by means of advanced experimental methods

The scientific objective of this WP is to obtain new knowledge about ageing and corrosion of materials, especially metals, stone and inorganic composites, and to find optimum ways to protect their surfaces. Models of the degradation of materials will be created and then calibrated and verified using the equipment of the Centre. Long-term monitoring will be carried out, and the behaviour of the materials will be studied in real climatic conditions. Another objective is to obtain data about the lifetime of historic materials, to make proposals for methods, to monitor the behaviour of materials and structures, and also to monitor defects on monuments. A partial objective is to innovate and maintain a database of structural defects and faults. CET will build a unique experimental and analytical infrastructure for studies of these scientific objectives, which will also be usable for more general tasks. This research package therefore plans to develop new experimental methods, and to elaborate proposals for new or innovated methods, instruments and equipment, especially for testing wood and inorganic composites. The radiography and microtomography module and the special climatic and analytical laboratories, together with the material analyses will be used mainly for the scientific tasks within WP2. Infrastructure further includes database and monitoring modules.

The research supervisors for Work Package 2 are
Ing. Daniel Vavřík, Ph.D. (1), for radiography
Ing. Kateřina Kreislová, Ph.D. (2 right), for material corrosion.



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Materials, technologies and methods for achieving long-term preservation (sustainability) of monuments

The objective of this research is to design, develop and verify new materials and technologies that are compatible with historic materials and technologies, focused on consolidating and restoring degraded historic materials and extending their lifetime and the lifetime of monuments. A further objective is to design a system for analysing the impacts of natural disasters and other threats to the building stock, with particular reference to the preservation of cultural heritage, and to propose procedures and technologies leading to the mitigation of damage caused by these threats. Natural threats (especially earthquakes, floods and landslides) include the effects of weather factors. This package will develop methods for optimizing preservation interventions using mobile diagnostic laboratories when emergency situations occur. An important objective is to create procedures and tools for evaluating and assessing the impacts of development programs (tourism, location, new architecture, etc.) on the sustainability of the monumental and socioeconomic qualities of historic settlements, and tools for integrating monuments into an urbanized environment.

The research supervisor for Work Package 3 is **Ing. Zuzana Slížková, Ph.D.**

The **CET mobile laboratory** forms part of the special research equipment, and is equipped for operation in the event of natural disasters, industrial failure, or for use on inaccessible monuments, structures and archaeological sites. The mobile laboratory is supervised by **Ing. Jan Válek, Ph.D.**

CET also maintains and operates a number of **monitoring stations** for studies of the impact of climate and weather parameters on the behaviour and performance of technical materials and cultural heritage objects. The data is collected in long-term **databases** on the characteristics of historic materials, on failures and defects, and on the dynamic response of bridges, telecommunication towers and masts.


Thermal Analys

CET – Climatic wind tunnel "Vincenc Strouhal"

CWT – designed as a closed circuit with controlled wind velocity and temperature conditions. It consists of climatic and aerodynamic parts. While the aerodynamic part provides well-fitted conditions to study wind effects on scaled model of prototypes, an equipment of the climatic part is suited for investigation of influences of weather including the wind, temperature, rain and heat radiation. Integral part of the tunnel equipment consists of instruments for airflow diagnostic, data acquisition system, direct pressure surface measurement, precise thermometry and of many other types of handy accessories for instant use. Workshops for manufacturing of testing models are available in the same building.

Using the cooling/heating exchanger, cycle temperature changing of the airflow is available in the whole tunnel within the range of –5 to 30 °C in a relatively short time period. In this section (2.5 × 3.9 m), the wind speed ranges from 0.8 to 18 m/s (depending on the position of the vertically moveable ceiling and flow nozzle). The rain intensity together with the size of drops is regulated to simulate the effects corresponding to drizzle or heavy rain. The radiation system with four infrared lamps with 8 kW power and maximal incidence of 60° to the floor is available.

Ice created on a bridge cable **(1)** and water penetration in a gothic pinnacle during wind driven rain **(2)**.

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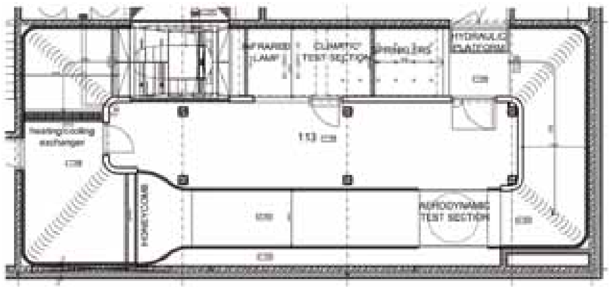
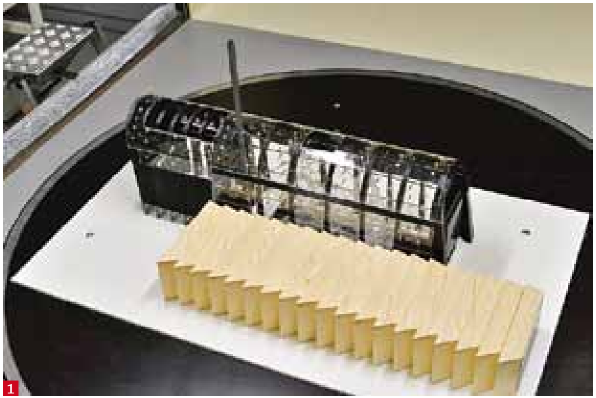


Aerodynamic section

Experiments in the field of wind effects on structures, wind characteristics, local wind environments, pedestrians comfort, aero-elastic structural response, diffusion, pollutant dispersion and matter transport, wind effects on building heat losses and ventilation, wind effects on transport systems, wind power generation.

The aerodynamic section consists of the converting nozzle with a honeycomb and the working part with turning table. The working part is in a rectangular cross-section area of 1.9 × 1.8 m. The total length of the working part is 11.0 m, including the turbulent generators. The simulation of the atmospheric boundary layer with demanded characteristics is based upon turbulent elements, such as spires, grids, barriers and floor roughness. The wind speed range for empty working section is 1.5–33.8 m/s or with special condition up to 50 m/s.

Scaled model tests of modern architecture. (1) Turbulence generators. (2)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Laboratory of the X-ray radiography and computed tomography

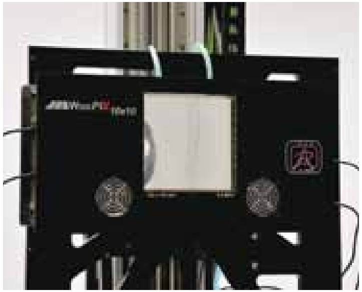
Largest single photon counting detector of the ionizing radiation in the world
Physical camera resolution (pixel size): 55 × 55 μm²
Number of pixels: 2560 × 2560 **(6.5 MegaPixels)**
Sensitive area: **14 × 14 cm²**
Readout speed: 1.5 fps

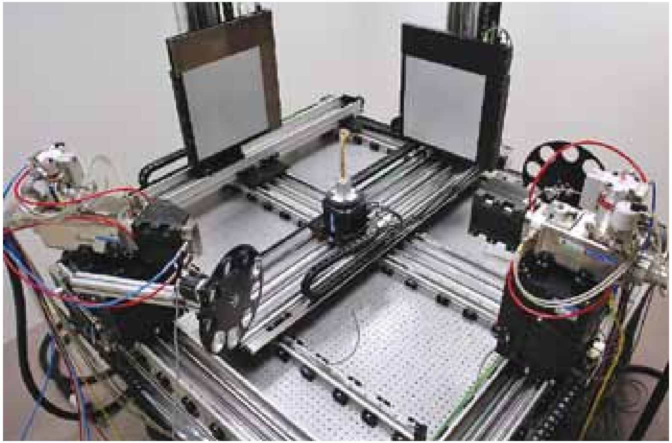
Combines both the Dual Source CT and the Dual Energy CT advantages

* two different spectra
* two different magnifications
* speeds up CT measurements – 2×

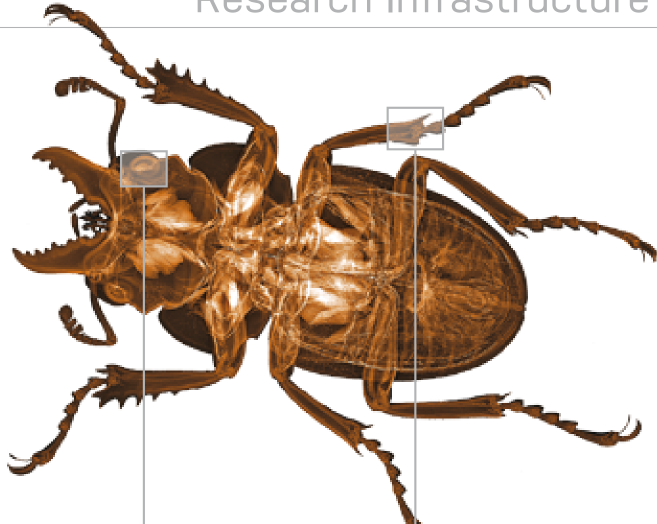
* **2× X-ray tube**
* **2× detector** – exchangeable
* **16 position axes** – controlled in real-time
* **Absolute measuring system** – accuracy < 1 μm
* **High precision rotation stage** – accuracy ~200 nm
* **HW & SW for beam hardening correction**
* **CT reconstruction software Volex** – EZRT (Fraunhofer-Entwicklungszentrum Röntgentechnik)

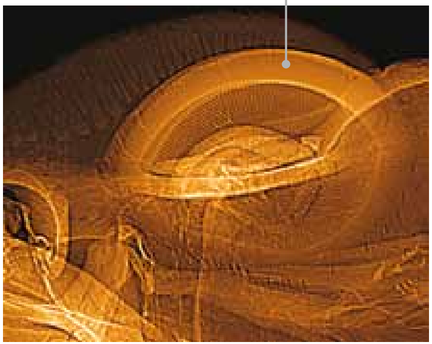
Laboratory is fully available for collaborative projects as well as for research contracts.

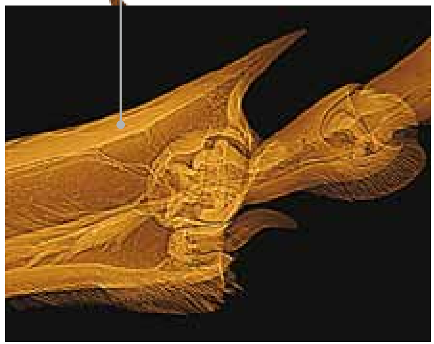




Examples: CT reconstruction of a rodent skull and high resolution X-ray radiography – ground beetle







Laboratories for material analyses

Thin section preparation. **(1)** Raman and FTIR microscopy. **(2)** XRD analyses. **(3)** SEM microscopy. **(4)** Thermal analysis. **(5)**

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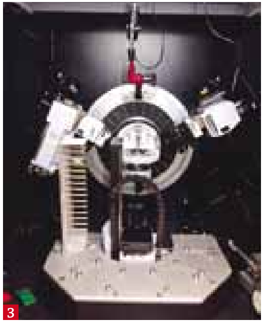

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Laboratories for study of physical material characteristics and durability

Climatic chambers. (1) Porosimetry. (2) Nanoindentation. (3) Biaxial loading frame (tension/compression/torsion). (4) Dilatometry. (5) Salt chamber. (6)


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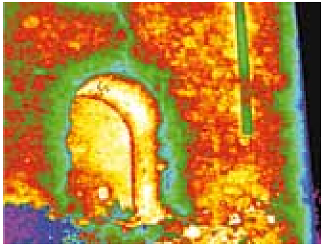
Mobile laboratory

The mobile laboratory is equipped for use in situ. This is for example during unexpected and industrial disasters or at difficult-to-reach cultural heritage places and archaeological sites. CET runs several monitoring stations used in research on effects of climatic and wind related parameters on behaviour of materials and cultural heritage objects. Databases made over a long term on properties of historic materials and their damages are important part of the infrastructure. The mobile laboratory is equipped with a car, 4 wheel drive, and a rich set of diagnostic instruments for analysis of physical and mechanical properties of various materials. For example for:

* **diagnostics of timber structures** (resistance micro drill Resistograph 4453-S, device for testing flexural strength of drilled cores Fraktometer II, ultrasonic tomograph Microsecond Timer 3D – 10 channels, videoscope VideoProbe XLGo+, including several regimes for measurements of dimensions, indentor Pilodyn 6J Forest, handheld mobile digital microscope G20 Advanced Pack 60× & 150×, timber-growing drills from three different producers, moisture meter WHT860, contact moisture meter L620),



* **diagnostics of masonry and concrete structures** (gas permeability Torrent, microwave HF moisture meter with probes for depth of 0–5 cm, 5–15 cm and 15–30 cm, Arbotech brick and masonry saw, set for micro-core sampling (core diam. 25 mm), Schmidt hammers for concrete and stone, endoscope),

* **monitoring station** (data-loggers for monitoring T and RH, contactless infra-thermometer up to 1000 °C, monitoring contact temperatures of materials, universal data logger with 9 inputs with sensors for T, RH, pressure and tension forces and displacements), Ground Penetration Radar, thermovision, etc.

Example of in situ measurements – Castle Hollenburg in Austria.

Centre excellence Telč – review of laboratories

WP1 Climatic wind tunnel

Research supervisor: **Assoc. Prof. Ing. Stanislav Pospíšil, Ph.D.**

Climatic wind tunnel “Vincenc Strouhal”
Head of Laboratory: **Prof. Ing. Sergii Kuznetsov, DrSc.**

WP2 Radiography and neutrongraphy

Research supervisor: **Ing. Kateřina Kreislová, Ph.D.**

Laboratory for material degradation and protection
Head of Laboratory: **Ing. Jiří Frankl, Ph.D.**

Research supervisor: **Ing. Daniel Vavřík, Ph.D.**

Laboratory for X-ray and neutron radiography
Head of Laboratory: **Ing. Ivana Kumpová**

WP3 Historic materials, structures and sites

Research supervisor: **Ing. Zuzana Slížková, Ph.D.**

Laboratory for porosimetry, microscopy and optical methods
Head of Laboratory: **Denis P. Flynn, Ph.D.**

Laboratory for physical-chemical analyses and material innovations
Head of Laboratory: **Dr. Alberto Viani, Ph.D.**

Mobile laboratory for diagnostics and wood research
Head of Laboratory: **Ing. Michal Kloiber, Ph.D.**

Laboratory for mechanical analyses and monitoring of materials and structures
Head of Laboratory: **Ing. Petr Šašek, Ph.D.**

Laboratory for sustainability of monuments and historic sites
Head of Laboratory: **MgA. Dana Macounová**

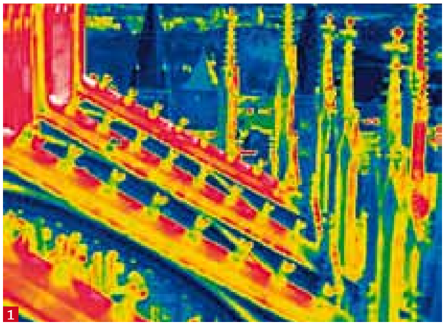
WP3 Lime kiln – Centre for research of traditional lime production

Head of the Centre: **Ing. Jan Válek, Ph.D.**

We help buildings and materials to stand up better to environmental impacts

Everybody knows that historic materials and monuments decay due to weathering. However, which processes really cause degradation? How rapidly do they act? Why does a failure occur in some cases but not in others? How do defects propagate? How does the surface of a material influence its performance? How can the life of materials be prolonged in aggressive environments? How do combinations of wind, rain and temperature act on materials and structures? These questions and others will be answered in the course of a project in the programme of research supported under GA ČR project P105/12/G059 **Cumulative time-dependent processes in building materials and structures.**

Temperature distribution and the character of the deformation in the structure of St. Vitus' Cathedral in Prague at 11.00 a.m. on July 2, 2006. **(1)**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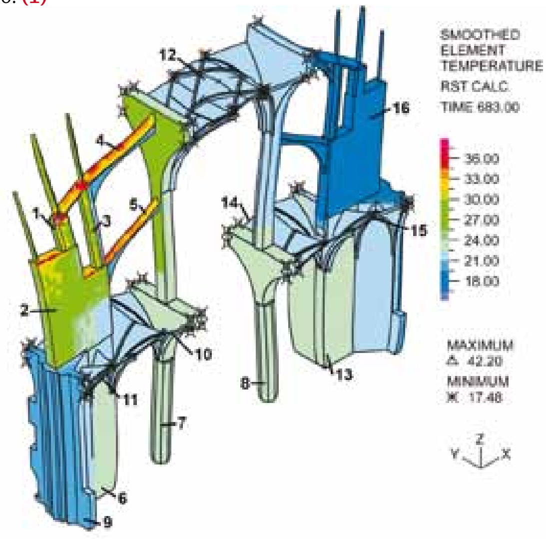
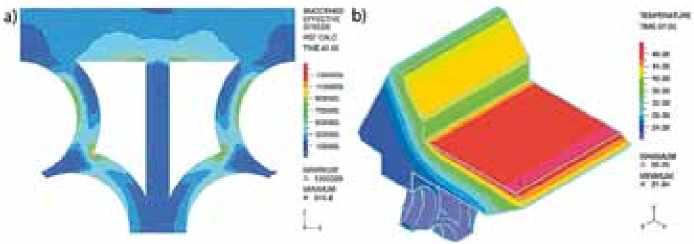


We help to control the environmental quality in monuments and museums

Can failures also occur inside buildings? What do we know about fatigue of materials subjected to climatic cycles? Which environment is safe for specific materials? Questions such as these are dealt with in GA ČR project P105/12/G059 **Cumulative time-dependent processes in building materials and structures**, and also by the NAKI Programme of the Czech Ministry of Culture DF12P01OVV027 **Unified modular system of remote on-line monitoring of environmental characteristics in deposits and installations**. This project works on setting suitable environmental parameters in various museums, and also on developing a system for collecting data on temperature, relative humidity, light intensity, vibration and chemical parameters. When the thresholds are exceeded, a warning message is transmitted to the site manager. This project is being carried out in cooperation with the National Museum in Prague.

These elements failed although nobody touched them. Examples of triforium tracery in St. Vitus' Cathedral in Prague (1) and in Notre Dame du Sablon in Brussels (2), damaged due to climatic cycles. The effective stress distribution is generated by the temperature fluctuations during solar heating.

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We help to mitigate or prevent damage from flooding and from rising damp

How can we protect monuments against floods? Which preventive measures are acceptable to the inhabitants of historic settlements? How do material characteristics change after water saturation? How do organisms colonize wet monuments after the water is released? What should municipal managements do to reduce damage from floods? What does the owner of a monument need to know before, during and after a flood? How does a biotic attack decrease the strength of wood? These questions and others are answered in the NAKI Programme project DF11P01OVV009 **Methodology and instruments for protecting cultural heritage and safeguarding it from the threat of flooding**, and in GA ČR project P105/11/P628 **Influence of mycological degradation on the mechanical characteristics of new and exposed wood.**

Our research improves the resistance of buildings and structures against earthquakes

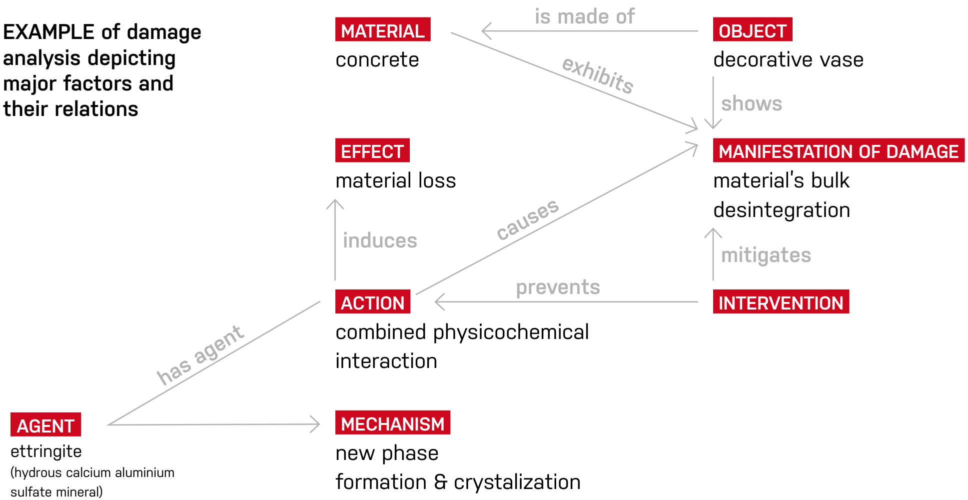
How can we protect monuments against seismic damage? How can we increase the resistance of historic structures and old buildings against dynamic loads? Which elements can increase energy dissipation during earthquakes? How can the safety of buildings be assessed, and which theories are applicable? How can we calculate the rigidity of historic structures, mainly floor structures? What can municipalities and regional authorities do to reduce losses and damage due to seismic events? These questions and many more are dealt with in the NIKER EC 7th Framework Programme project (no. 244123) **New integrated knowledge-based approaches to the protection of cultural heritage from earthquake-induced risks**.

Investigations of historic carpentry joints with increased energy dissipation, experimental determination of the shear stiffness of historic floor structures, research on strengthening adobe walls against repeated cyclic loading.

We learn from analyses of historic mistakes, defects and failures – the MONDIS project

Why is data on damage and failures valuable? What can be mined from it? What can cause a specific kind of damage? What are the optimum remedial or repair measures for specific types of damage or failure? Which types of damage are typical of specific materials? How can failures be prevented? The MONDIS project builds a knowledge-based system for documenting and analysing damage and failures of cultural heritage objects, with the aim of increasing our understanding of the causal links between damage, external load, materials and construction technology. This study is supported under the NAKI Programme in project DF11P01OVV002 **Failures of immoveable heritage: a knowledge-based system for analysing and designing interventions and preventive measures**.

EXAMPLE of damage analysis depicting major factors and their relations



We investigate the efficiency of earlier methods used for protecting historic materials

How can we assess the efficiency of selected approaches and methods for protecting historic materials from the point of view of their durability and resistance against weathering effects? The Last Judgement **(1)** mosaic at Prague Castle should benefit from the installation of a special sensor which will check reflectance and transmission of light. This will be our contribution to NAKI MK ČR project DF12P01OVV017 **Technology for maintaining and conserving the Last Judgement mosaic, and methods for renewed restoration and conservation of medieval glass** (in cooperation with the University of Chemical Technology in Prague).

How successful have earlier repairs and protective measures for important monuments been? How can we make a non-destructive assessment of the state and the subsurface condition of historic materials? Which material characteristics can be determined using NDT methods for designing repair or restoration interventions? These questions will be answered in the course of the NAKI Programme project DF11P01OVV027 **Selected conservation procedures to increase the quality of care for sculptural and building monuments** (in cooperation with the Faculty of Restoration of the University of Pardubice).

Georadar diagnostic tests on Charles Bridge **(2)**, and locating subsurface defects on the relief of Neptune at the State Chateau in Telč, using active thermovision **(3)**.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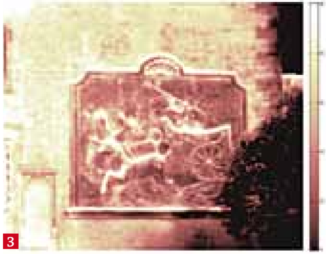
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We reveal the mysteries of old masters

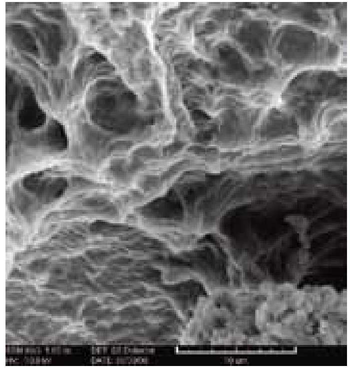
How did old craftsmen burn lime in order to produce mortars with good strength and durability? How does the raw material influence the quality of the lime? Can we determine the provenance of historic mortars? Is it reasonable from the conservation and ecology point of view to re-introduce lime burning on large construction sites? These questions and many others will be answered in NAKI Programme project DF11P01OVV010 **Traditional lime technologies of historic buildings and their present-day use**.

An experimental lime kiln specially designed for research on traditional materials. Dr. Jan Válek is controlling the burning process. (1)
Initiation of lime slaking due to relative air humidity. SEM 40 000×. (2)

2

We study the performance of historic materials as an inspiration for the design of new technologies

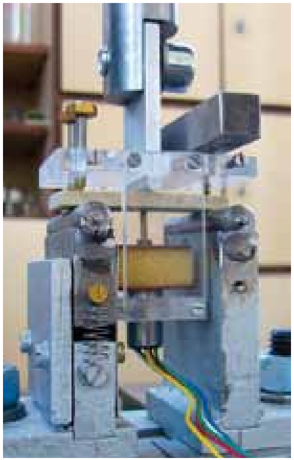
How can we make a theoretical description of the contribution of added natural fibres to the performance of lime composites? We know why crushed brick or pottery was added into lime mortars, but what is their exact influence, and how does this influence come about? What happens at the interface between the binder and the brick aggregate? How can we design lime mortars that are resistant to frost and salts? How can we increase the water repellence of a mortar? Issues of this kind are studied within NAKI Programme project DF11P01OVV008 **High performance and compatible lime mortars for extreme applications when carrying out restorative repairs and preventive maintenance of architectural heritage** (in cooperation with the Civil Engineering Faculty of the Czech Technical University in Prague).

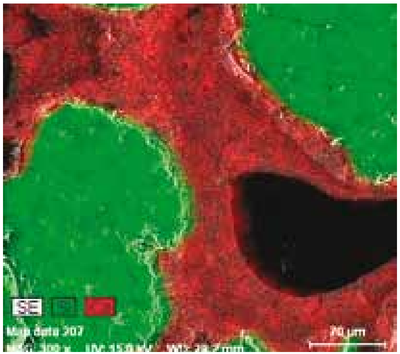


We restore strength to decaying materials

How can we safeguard decaying mortar or stone? What is the optimum technology for consolidating a specific deteriorated material? How do various impregnation agents influence the material characteristics of substrates? How can we remove residual old conservation layers or soiling by vandals from the surface of a monument? How can we prevent water penetrating into porous materials? Questions such as these are answered in research projects DF11P01OVV012 **New materials and technologies for conserving the surfaces of monuments and for preventive conservation** (in cooperation with the Jaroslav Heyrovský Institute of Physical Chemistry of the Academy of Sciences of the Czech Republic and the University of Chemistry Technology in Prague) and in GA ČR project103/09/2067 **Consolidation of degraded lime mortars and plasters**. These projects are linked to the recently completed 7th FP EC STONECORE project Stone Conservation for Refurbishment of Buildings.

An example of nanolime structures and the effects of strengthening a lean lime mortar.





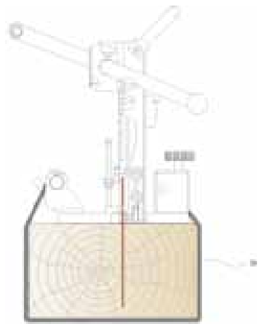
We help to improve the quality of surveys, and we design compatible technologies for repairs to monuments

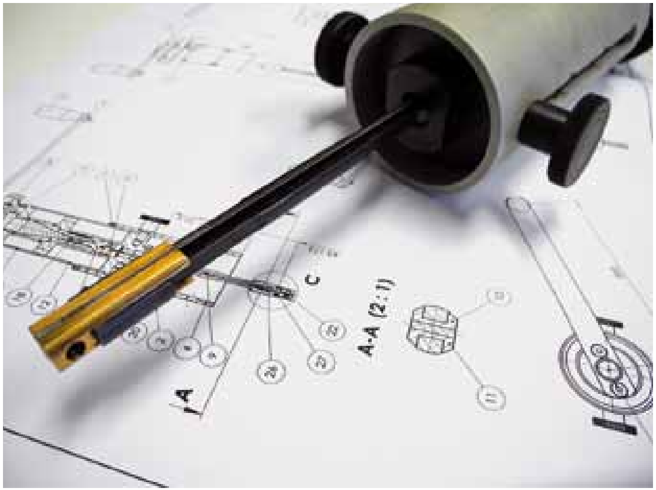
How can we exploit modern information technologies optimally for preventive conservation? Is it possible to cooperate on a European level to create a common cultural heritage identity card? The 7th FP EC project 226995 EU CHIC **Cultural Heritage Identity Card** shows present-day possibilities in this field.

What surveys are necessary when preparing for an intervention on a cultural heritage object? What material parameters do we need to know in order to design optimum technologies? How can we choose a suitable material and prepare it for making repairs? What we can learn about original technologies with the use of detailed traces analysis? How can additional interventions and modifications be recognized? How can we design traditional carpentry technologies for restoring timber structures? We seek answers to these and similar questions, in collaboration with craftsmen, restorers and conservators, in three projects in the NAKI Programme 18/2012/OVV **Conditions and requirements for compatible care for historic inorganic porous materials**, 20/2012/OVV project **A complex methodology for the selection and craft preparation of replacement stone for repairs to historic ashlar stone masonry**, and DF12P01OVV004 **Design and assessment of carpentry joints in historic structures** (some of these projects in cooperation with the Civil Engineering Faculty of the Czech Technical University in Prague and the National Technical Museum in Prague).

We develop new diagnostic methods and devices

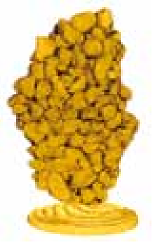
How can we determine the mechanical characteristics of built-in timber in buildings? How can we identify internal damage and decay? For these questions, help is available from new devices being developed within research projects NAKI MK ČR DF11P01OVV001 **Diagnostics of damage and the remaining life of cultural heritage objects**, and GA ČR P105/10/P573 post-doc grant project **Behaviour of wood during rod driving.**



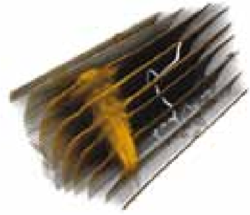


We develop new diagnostic methods and devices

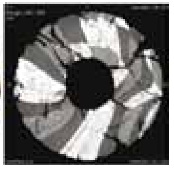
How can we make direct measurements of the water uptake of porous materials on complex structures? How can we measure the strength of extracted stone or building materials on site? How can we simplify microtopography measurements? Answers will be provided with the use of new devices and testing or experimental methods developed within the NAKI MK ČR project DF11P01OVV001 **Diagnostics of damage and the remaining life of cultural heritage objects**.




We educate and train new scientists

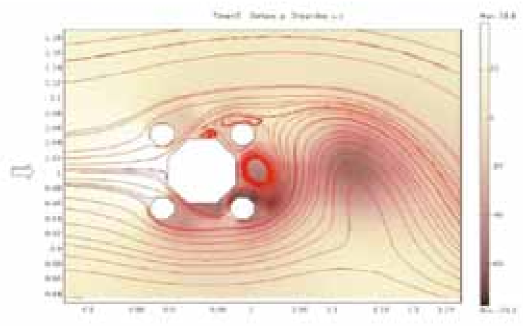


We deliver lectures at Czech and foreign universities, and we are the lecturers and thesis supervisors for the SAHC (Structural Analysis of Historic Constructions), international master's programme, and we supervise doctoral students and student projects.

We support innovations and technology transfer

We monitor and test cultural heritage objects, analyze historic materials, design and test new materials and protective technologies, we organize workshops, courses and lectures for professionals as well as for the public, we offer internships for research and development workers from industry, schools, research institutes and the public sector (with support from the Knowledge for Competitiveness Operational Programme). We give consultations and training courses on the application of nanomaterials in conservation/restoration of cultural heritage.

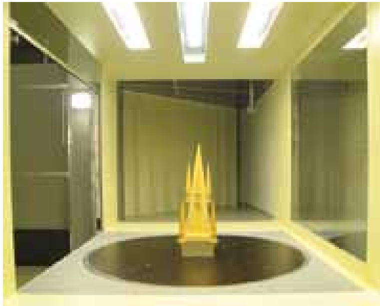


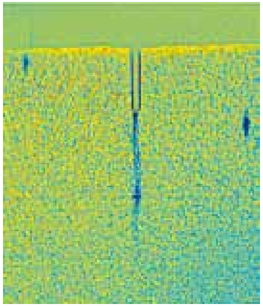
We provide unique expert activities for partners from industry and from the public sector

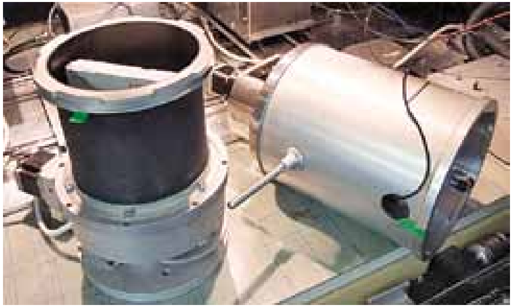
Our expert activities are not limited to cultural heritage.

We provide consultations in aeroelasticity and aerodynamics of modern structures and in architecture. We have designed a special unique device for studying the self-excited vibrations of engineering structures, which enable fast changes of relevant structural parameters. The device has been used in the design of modern bridges in the Czech Republic and abroad (e.g. over the Rhine, in Germany). We make theoretical models of the airflow around complex forms and also carry out experiments in the wind tunnel and in situ measurements on real structures.
(The illustrative figures show a vibration test on a model of a bridge section and the airflow around a church tower).

Radiography has proved to be a very effective method for analysing historic and modern materials, for studying their microstructure and their damage mechanisms. The illustrative figures show X-ray dynamic defectoscopy of fracture damage to a silicate composite. The fracture processing zone (FZP) is well visible here, and is measured from a change in the material density in front of the crack tip. Further examples show X-ray micro CT used in a study of internal biological damage to wood, for measurements of the porosity of clay and cellulose poultice desalination materials, and in an analysis of an archaeological artefact – a glass millefiori bead.







Project registration number: CZ.1.05/1.1.00/02.0060
Operational programme: OP VaVpI (Science and Research for Innovations)
Priority: 1. European Centres of Excellence
Project title: Centre of Excellence Telč
Applicant: Institute of Theoretical and Applied Mechanics ASCR, v. v. i.
Grand amount: 238 mil. CZK
Grantor: European Regional Development Fund and Ministry of Education, Youth and Sports

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Telč – on the UNESCO's List of World Cultural Heritage

MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

EVROPSKÁ UNIE
EVROPSKÝ FOND PRO REGIONÁLNÍ ROZVOJ
INVESTICE DO VAŠÍ BUDOUCNOSTI

2007–13
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